Patent Claims

1. A circuit arrangement for rectifying the output voltage of a sensor supplied from an oscillator for a non-electrical variable, whose amplitude and phase angle is a measure of the non-electrical variable, **characterized**

- by the fact that the output voltage (u_1) of the sensor (11) is supplied to a ramp-generating circuit arrangement (10; 45; 48),
- by the fact that the mathematical sign of the transmission behavior of the ramp-generating circuit arrangement (10; 45; 48) can be controlled, and
- by the fact that the mathematical sign of the transmission behavior of the ramp-generating circuit arrangement (10; 45; 48) is controlled by a switching signal (u_0*), whose flanks correspond to the zero crossings of the output voltage (u_1) of the sensor (11).

2. The circuit arrangement as claimed in claim 1, **characterized** by the fact that a signal conditioner (18) uses the comparator function and dead time to convert the output voltage (u_0) of the oscillator (17) to the switching signal (u_0*).

3. The circuit arrangement as claimed in claim 2, **characterized** by the fact that the dead time of the signal

conditioner (18) shifts the phase angle of the switching signal (u_0*) with respect to the output voltage (u_0) of the oscillator (17) through an angle such that the flanks of the switching signal (u_0*) correspond to the zero crossings of the output voltage (u_1) of the sensor (11).

4. The circuit arrangement as claimed in claim 2 or claim 3, **characterized**

- by the fact that the output voltage (u_1) of the sensor (11) is supplied to an amplifier circuit (20) having a gain with a controllable mathematical sign,
- by the fact that the mathematical sign for the gain of the amplifier circuit (20) is controlled as a function of the switching signal (u_0*), and
- by the fact that a ramp generator (21; 38) is connected downstream of the amplifier circuit (20), no mathematical sign - inversion being carried out in the ramp generator (21; 38).

5. The circuit arrangement as claimed in claim 4, **characterized**

- by the fact that the output voltage (u_1) of the sensor (11) is supplied to the inverting input of a first operational amplifier (23) via a first resistor (24),

- by the fact that the output voltage (u_2) of the first operational amplifier (23) is supplied to its inverting input via a second resistor (25),
- by the fact that the output voltage (u_1) of the sensor (11) is supplied to the non-inverting input of the first operational amplifier (23) via a third resistor (26), and
- by the fact that the non-inverting input of the first operational amplifier (23) is connected to the reference potential via a switch (27) which is controlled by a switching signal (u_0*).

6. The circuit arrangement as claimed in claim 5, **characterized** by the fact that the first (24) and the second (25) resistor have the same resistance value.

7. The circuit arrangement as claimed in one of claims 4 to 6, **characterized** by the fact that the ramp generator (21) has an inverting transmission behavior.

8. The circuit arrangement as claimed in claim 7, **characterized**

- by the fact that the ramp generator (21) has a second (30) and a third (31) operational amplifier,
- by the fact that the non-inverting input of the second operational amplifier (30) is supplied the output

voltage (u_2) of the amplifier circuit (20) via a fourth resistor (32) and the output voltage (u_4) of the third operational amplifier (31) via a fifth resistor (33),

- by the fact that the inverting input of the second operational amplifier (30) is connected to the reference potential,
- by the fact that the inverting input of the third operational amplifier (31) is supplied its output voltage (u_4) via a capacitor (35) and the output voltage (u_3) of the second operational amplifier (30) via a sixth resistor (34), and
- by the fact that the non-inverting input of the third operational amplifier (31) is connected to the reference potential.

9. The circuit arrangement as claimed in claim 8, **characterized** by the fact that the fourth (32) and the fifth (33) resistor have the same resistance value.

10. The circuit arrangement as claimed in one of claims 4 to 6, **characterized** by the fact that the ramp generator (38) has a non-inverting transmission behavior.

11. The circuit arrangement as claimed in claim 10, **characterized**

- by the fact that the ramp generator (38) has a second (30) and a third (31) operational amplifier,
- by the fact that the inverting input of the second operational amplifier (30) is supplied the output voltage (u_2) of the amplifier circuit (20),
- by the fact that the non-inverting input of the second operational amplifier (30) is supplied the output voltage (u_6) of the ramp generator (38),
- by the fact that the inverting input of the third operational amplifier (31) is supplied its output voltage (u_6) via a capacitor (35) and the output voltage (u_5) of the second operational amplifier (30) via a sixth resistor (34), and
- by the fact that the non-inverting input of the third operational amplifier (31) is connected to the reference potential.

12. The circuit arrangement as claimed in claim 10, **characterized**

- by the fact that the output voltage (u_2) of the amplifier circuit (20) is supplied to the inverting input of the second operational amplifier (30) via a seventh resistor (41),

- by the fact that the output voltage (u_2) of the amplifier circuit (20) is supplied to the non-inverting input of the second operational amplifier (30) via an eighth resistor (42),
- by the fact that a ninth resistor (43) is arranged between the output of the third operational amplifier (31) and the non-inverting input of the second operational amplifier (30),
- by the fact that the inverting input of the third operational amplifier (31) is supplied its output voltage (u_6) via a capacitor (35) and the output voltage (u_5) of the second operational amplifier (30) via a sixth resistor (34), and
- by the fact that the non-inverting input of the third operational amplifier (31) is connected to the reference potential.

13. The circuit arrangement as claimed in claim 12, **characterized** by the fact that the eighth (42) and the ninth (43) resistor have the same resistance value.

14. The circuit arrangement as claimed in one of claims 1 to 3, **characterized**

- by the fact that the output voltage (u_1) of the sensor (11) is supplied to a controlled ramp generator (45;

48), which can be changed over between inverting and non-inverting transmission behavior, and

- by the fact that the mathematical sign of the transmission behavior is controlled as a function of the switching signal (u_0*).

15. The circuit arrangement as claimed in claim 14, **characterized**

- by the fact that the controlled ramp generator (45) has a second (30) and a third (31) operational amplifier,
- by the fact that the output voltage (u_1) of the sensor (11) is supplied to the inverting input of the second operational amplifier (30) via a seventh resistor (41),
- by the fact that a switch (46), which is controlled by the switching signal (u_0*), is arranged between the inverting input of the second operational amplifier (30) and the reference potential,
- by the fact that the output voltage (u_1) of the sensor (11) is supplied to the non-inverting input of the second operational amplifier (30) via an eighth resistor (42),
- by the fact that the output voltage (u_8) of the controlled ramp generator (45) is supplied to the non-inverting input of the second operational amplifier (30) via a ninth resistor (43),

- by the fact that the inverting input of the third operational amplifier (31) is supplied its output voltage (u_8) via a capacitor (35) and the output voltage (u_7) of the second operational amplifier (30) via a sixth resistor (34), and
- by the fact that the non-inverting input of the third operational amplifier (31) is connected to the reference potential.

16. The circuit arrangement as claimed in claim 15, **characterized** by the fact that the eighth (42) and the ninth (43) resistor have the same resistance value.

17. The circuit arrangement as claimed in claim 15 or claim 16, **characterized**

- by the fact that a tenth resistor (51) is arranged between the output of the second operational amplifier (30) and the sixth resistor (34),
- by the fact that the connecting point (52) between the tenth resistor (51) and the sixth resistor (34) is connected, via a first diode (54), to a negative auxiliary voltage ($-U_H$) and, via a second diode (55), to a positive auxiliary voltage ($+U_H$) having the same value, and
- by the fact that the value for the auxiliary voltages ($-U_H$, $+U_H$) is smaller than the value for the output

voltage (u_7) of the second operational amplifier (30) when it is overloaded.

18. The circuit arrangement as claimed in claim 17, **characterized** by the fact that a second capacitor (58) is arranged in parallel with the series circuit comprising the sixth (34) and the tenth (51) resistor.

19. The circuit arrangement as claimed in one of the preceding claims, **characterized** by the fact that the ramp steepness of the ramp generator (21; 38; 45; 48) is greater than the maximum steepness of the useful signal of the output voltage (u_1) of the sensor (11; 11′; 78).

20. The circuit arrangement as claimed in one of the preceding claims, **characterized** by the fact that at least one linear filter (50) is connected downstream of the ramp-generating circuit arrangement (10; 45; 48).

21. The circuit arrangement as claimed in claim 20, **characterized** by the fact that the linear filter (50) is an active, second-order bandpass filter having single positive feedback.

22. The circuit arrangement as claimed in claim 20 or claim 21, **characterized** by the fact that the linear filter (50) is in the form of a Bessel filter.

23. The circuit arrangement as claimed in one of the preceding claims, **characterized** by the fact that a matching circuit (68) is arranged between the sensor (11'; 78) and the ramp-generating circuit arrangement (10) and amplifies the amplitude of the output voltage ($u_{13} - u_{14}$; $u_{85} - u_{82}$) of the sensor (11'; 78).

24. The circuit arrangement as claimed in one of the preceding claims, **characterized** by the fact that the matching circuit (68) isolates the reference potentials ($M_{11'}$ and M_{10}, respectively) of the sensor (11') and the ramp-generating circuit arrangement (10).

25. The circuit arrangement as claimed in claim 23 or claim 24, **characterized**

- by the fact that a first output voltage (u_{13}) of the sensor (11') is supplied to the inverting input of a fourth operational amplifier (69) via an eleventh resistor (71),
- by the fact that a second output voltage (u_{14}) of the sensor (11') is supplied to the non-inverting input of

the fourth operational amplifier (69) via a twelfth resistor (72),

- by the fact that the output of the fourth operational amplifier (69) is connected to the inverting input of the fourth operational amplifier (69) via a thirteenth resistor (73), and
- by the fact that the non-inverting input of the fourth operational amplifier (69) is connected to the reference potential (M_{10}) via a fourteenth resistor (74).

26. The circuit arrangement as claimed in one of the preceding claims, **characterized** by the fact that the sensor is an inductive movement sensor (11; 11'), and by the fact that the amplitude and the phase angle of the output voltage (u_1; u_{13} - u_{14}) of the movement sensor (11, 11') is a measure of the deflection (s) of a ferromagnetic core (15).

27. The circuit arrangement as claimed in one of claims 1 to 25, **characterized** by the fact that the sensor is a capacitive movement sensor (78), and by the fact that the non-electrical variable (s) alters a capacitance (C_1, C_2) of the movement sensor (78) such that the amplitude and the phase angle of the output voltage (u_{85} - u_{82}) of the movement sensor (78) is a measure of the non-electrical variable (s).